2.13 Bridges and Structures

2.13.1 *General*

The Design-Builder shall perform all Work necessary to complete the bridges, buried structures, and other structures for the Project. Elements of Work shall include, at a minimum, the following:

- Remove existing fish barriers identified in each Culvert Bundle Amendment.
- Design and construct replacement structures that are fish passable at the locations identified in each Culvert Bundle Amendment.

The plans showing the existing bridges, buried structures, and other structures are located in the existing As Built, and are provided as Reliance Documents.

2.13.1.1 Forward Compatibility

This Section is intentionally omitted.

2.13.2 *Mandatory Standards*

The following is a list of Mandatory Standards that shall be followed for all design and construction related to this Section as referenced in TR Section 2.2, *Mandatory Standards*.

1. Special Provisions (Appendix 4)
2. Standard Specifications M 41-10 (Appendix 4)
3. WSDOT *Bridge & Structures Office Design Memoranda* (Appendix 4)
4. WSDOT *Bridge Design Manual LRFD* M 23-50 (Appendix 4)
5. WSDOT *Geotechnical Design Manual* M 46-03 (Appendix 4)
6. *AASHTO Guide Specifications for LRFD Seismic Bridge Design*
7. *FHWA Seismic Retrofitting Manual for Highway Structures: Part 1 - Bridges*
8. *AASHTO LRFD Bridge Design Specifications*
9. *FHWA Evaluating Scour at Bridges, HEC-18*
10. *AASHTO Manual for Bridge Evaluation*
11. WSDOT *Design Manual* M 22-01 (Appendix 4)
12. WSDOT *Plans Preparation Manual* M 22-31 (Appendix 4)
13. WSDOT *Construction Manual* M 41-01 (Appendix 4)
14. *AASHTO LRFD Bridge Construction Specifications*
15. *AASHTO Guide Design Specifications for Bridge Temporary Works*

16. WSDOT *Materials Manual* M 46-01 (Appendix 4)
17. WSDOT *Standard Plans* M 21-01 (Appendix 4)
18. *Qualified Products List* (QPL) https://www.wsdot.wa.gov/Business/MaterialsLab/QPL.htm
19. *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*
20. *AWS Structural Welding Code - Steel* (AWS D1.1/D1.1M)
21. *AWS Structural Welding Code - Reinforcing Steel* (AWS D1.4/D1.4M)
22. *AASHTO/AWS Bridge Welding Code* (AWS D1.5M/D1.5)
23. *American Concrete Institute Code Requirements for Environmental Engineering Concrete Structures* (ACI 350)
24. *AASHTO Technical Manual for Design and Construction of Road Tunnels – Civil Elements* (publication FHWA-NHI-10-034)

2.13.2.1 Bridge Design Manual Rights and Responsibilities

The WSDOT *Bridge Design Manual*, as modified by the WSDOT *Bridge & Structures Office Design Memoranda*, allocates responsibilities as follows:

- Rights and Responsibilities - The following clarifies which rights and responsibilities discussed in the WSDOT *Bridge Design Manual* are applicable to the Design-Builder:
  - The Design-Builder shall complete all analyses, evaluations, load ratings, plans, and specifications discussed in the WSDOT *Bridge Design Manual*.
  - All such analyses, evaluations, load ratings, plans, and specifications are subject to Review and Comment by WSDOT.
  - All references to WSDOT Sections, offices, and engineers shall mean WSDOT.
- Where the WSDOT *Bridge Design Manual* or the WSDOT *Bridge & Structures Office Design Memoranda* requires approval by the WSDOT Bridge Design Engineer, the Design-Builder shall be responsible for obtaining approval from the WSDOT Engineer prior to proceeding with the design.

2.13.3 *Personnel Requirements*

The Design-Builder shall provide a Structural Lead Engineer (SLE) to manage and review all aspects of the structural Work completed for the Project. The SLE shall ensure that all design and construction of permanent Work is in conformance

with the PDB Contract and Quality Management Plan and for coordinating all structural design elements of the Project.

The SLE shall have a minimum of 10 years of experience in the design of bridges, retaining walls, and other highway-related structures. This individual shall be registered as a Structural Engineer in the State in accordance with RCW 18.43.040.

The Engineer of Record (EOR) for all structural engineering Design Documents for significant structures described in RCW 18.43.020(12) and for all bridges shall have a minimum of 10 years of experience in the design of bridges, retaining walls, and other highway-related structures. The EOR shall be registered as a Structural Engineer in the State in accordance with RCW 18.43.040.

The Engineer of Record (EOR) for all structural engineering Design Documents for all other structures in the Project shall be registered as a Professional Engineer in the State in accordance with RCW 18.43.040.

2.13.4 *Design Criteria*

The Design-Builder shall analyze and design all new permanent bridges, buried structures and other structures, and all existing structural elements whose load-carrying capacities are altered by the Work, using Load and Resistance Factor Design (LRFD) as defined in the WSDOT *Bridge Design Manual* and the *AASHTO LRFD Bridge Design Specifications*.

The Design-Builder shall design and construct permanent bridges, buried structures, and other structures to achieve a minimum design life of 75 years. Minimum clearances shall be as follows and shall be maintained at all times during and after construction:

- New overwater structures shall have a minimum vertical under clearance that meets the greater of the requirements specified in TR Section 2.30, *Fish Passage*, and the following:
    - For a bridge structure, a minimum of 3 feet above the 100-year Mean Recurrence Interval (MRI) water surface to the bottom of girders
    - For a buried structure, a minimum of 6 feet above the thalweg to the bottom of the top slab.
- New vehicular structures over a roadway shall provide a minimum vertical clearance of 16’ - 6”.

When multiple minimum clearances are listed the required minimum vertical clearance shall be the greater value.

Minimum foundation cover requirements shall be as follows:

- The top of pedestals, spread footings, pile caps, and shaft caps shall be below the 100-year scour level, or it shall be located outside of the minimum "Hydraulic Clear Span" as defined in TR Section 2.30, *Fish Passage*.
- The bottom of spread footings, pile caps, and shaft caps, (or bottom of the seal, if used), shall be 2 feet below the calculated 500-year scour level.

Refer to TR Section 2.11, *Roadway*, for design criteria regarding barrier type and height. All bridge barriers shall be 42 inches in height, measured from the top of the finished roadway and bridge deck, and shall use the design criteria for Test Level 4 (TL-4) or TL-5 (as referenced in the *AASHTO LRFD Bridge Design Specifications*), as designated by the WSDOT Engineer.

2.13.4.1 Bridge Design Criteria

The following permanent bridge superstructure types are permitted for this Project:

- Prestressed Concrete I-Girder and Wide Flange I-Girder
- Prestressed Concrete Slab Girder
- Prestressed Concrete Wide Flange Thin Deck Girder
- Prestressed Concrete Wide Flange Deck Girder with UHPC Closures and Concrete Overlay
- Prestressed Concrete Tub Girder
- Spliced Prestressed Concrete Girder
- Post-Tensioned Concrete Box Girder
- Rolled Steel Beams
- Steel Plate Girder
- Steel Box Girder

Masonry or timber shall not be used as materials for permanent bridge superstructures or substructures.

Intermediate hinges shall not be used with permanent bridge structures.

Non-redundant, fracture-critical pier caps shall not be used.

Welding on any steel elements shall be in accordance with AWS D1.5.

2.13.4.1.1 Bridge Seismic Design Criteria

The seismic analyses and design for all new permanent bridge foundations and retaining walls shall be in accordance with the *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, as modified by the WSDOT *Bridge Design*

Manual, and the code-based response spectra and coefficients applicable to this Project as defined in TR Section 2.6, *Geotechnical,* and the WSDOT *Geotechnical Design Manual*.

All bridges on this project shall have an operational classification of normal, except for the bridges following:

To be determined during the Phase 1 Services Period **[Note: This paragraph will be updated as part of the Project Implementation Amendment.]**

2.13.4.1.1.1 Liquefaction and Lateral Spread

All structural elements of the new bridges and/or buried structures shall be designed for liquefaction and lateral spread per the requirements of the WSDOT Bridge Design Manual and WSDOT Geotechnical Design Manual.

2.13.4.1.2 Bridge Widening Design Criteria

This Section is intentionally omitted.

2.13.4.1.3 Existing Bridge Monitoring Criteria

This Section is intentionally omitted.

2.13.4.1.4 Bridge Load Ratings

All new bridges, widened bridges, rehabilitated bridges, and detour bridges that carry vehicular loads and that are 20 feet or more in span length (measured from back-to-back of pavement seats along the centerline of the roadway) shall be load rated in accordance with the WSDOT *Bridge Design Manual*. Detour bridges for the purpose of load rating are defined as bridges that will be in place for more than 90 days. The Design-Builder will not be required to upgrade the existing structures for a reduction in the load rating due to bridge overlay replacements, removal, and replacement of traffic barriers, or both.

2.13.4.1.5 Precast Prestressed Concrete Girders

Precast prestressed concrete girders include both pre-tensioned and post-tensioned girders.

The Design-Builder shall provide continuity reinforcement at intermediate piers in the bridge deck to resist negative moments due to live load and superimposed dead loads. Prestressed concrete girders shall be designed as a simple span for all single-span and multi-span bridges.

2.13.4.1.6 Steel Plate Girders and Steel Box Girders

The main longitudinal load-carrying girders shall be cambered during fabrication. Heat-cambered rolled girders shall not be used except as secondary members or

temporary girders. Steel superstructures shall have a cast-in-place reinforced concrete bridge deck designed to be composite for live loads.

Drip plates shall be provided on the bottom flanges on the exterior side of the exterior steel plate girders to direct water runoff away from bearings and bridge seats.

With the exception of weathering steel that is used east of the Cascades, all structural steel shall be painted in accordance with Section 6-07 of the Standard Specifications.

2.13.4.1.7 Bridge Approach Slabs

The Design-Builder shall provide a 25-foot minimum length (measured perpendicular to the pavement seat) cast-in-place reinforced concrete bridge approach slab at each end of new vehicular bridges. Semi-integral abutments or stub abutments shall have approach slab anchors at the ends of each new vehicular bridge. L-type abutments shall have the bridge approach slab pinned to the abutment. The bridge approach slab joints with the pavement section shall be perpendicular to the travel lanes. This joint shall be continuous across the full width of the bridge approach slab. Bridge approach slabs shall extend the full width of the bridge deck and traffic barriers. Longitudinal joints in new bridge approach slabs shall be placed at permanent lane lines.

Bridge approach slab skews shall not exceed 30 degrees.

Approach slabs for buried structures directly exposed to vehicular traffic may be omitted as long as the criteria contained in WSDOT Geotechnical Design Manual Chapter 8, Abutment Transitions are met and the following additional criteria:

- Structural clear span is less than 30’
- Structure is not on a Freight and Goods Transportation System T1 corridor
- Structure is not on a seismic lifeline route

2.13.4.1.8 Bridge Foundations

The Design-Builder shall construct bridge abutments, wingwalls, and curtain walls with precast or cast-in-place reinforced concrete. Where structural earth walls adjoin bridge abutments or curtain walls, the joint shall be a single vertical joint full height to the bottom of the traffic barrier. Curtain walls at bridge abutment wall corners shall be cast-in-place walls integral with the abutment walls and extending at least to the back of the footings. All girder seats at abutments and pier caps shall be sloped to drain moisture accumulation.

The Design-Builder shall use wingwalls, curtain walls, and retaining walls as required by slope geometry and under-bridge clearances. These walls shall prevent soil slopes from spilling onto girders and bearings. End slopes shall meet

stability requirements defined in TR Section 2.6, *Geotechnical,* and the WSDOT *Geotechnical Design Manual*, and shall be no steeper than 1.5H:1V.

2.13.4.1.9 Bridge Decks and Expansion Joints

The Design-Builder shall design and construct all vehicular bridge decks using cast-in-place reinforced concrete or stay-in-place concrete deck panels in accordance with Section 15.5.5 of the WSDOT *Bridge Design Manual*. The bridge deck protection system for new and existing vehicular bridges shall be in accordance with Section 15.5.5.D of the WSDOT *Bridge Design Manual*. Bituminous or bituminous-with-membrane overlays for permanent bridge deck construction on new vehicular bridges shall not be used.

The bridge deck for widened structures shall be continuous between expansion joints and shall match the existing expansion joint locations. Expansion joint headers shall be rebuilt the entire width of the new and existing bridge deck. Strip seals and compression seals shall be removed and replaced with new seals, in one continuous piece, for the entire width of the new and existing bridge deck.

The Design-Builder shall not use steel finger expansion joints on new bridges. All expansion joints shall be watertight. Longitudinal expansion joints shall not be used on new bridges or widened bridges. The maximum skew for expansion joints on new bridges shall be 30 degrees as measured perpendicular to the centerline of the bridge deck. Longitudinal joints in overlays on existing bridges needed for construction staging shall be placed along permanent lane lines.

2.13.4.1.10 Slope Protection

Slope protection shall reduce or eliminate the need for maintenance; lessen or eliminate negative visual impacts associated with soil erosion, weed growth, trash accumulation, and vandalism; and conform to the requirements described in TR Section 2.15, *Roadside Restoration*.

2.13.4.1.11 Bridge Barriers and Railings

Vertical 32-inch height barrier and Bridge Railing Type BP shall be used adjacent to sidewalks. The Bridge Railing Type BP standard details may be modified by the Design-Builder to incorporate the aesthetic requirements of TR Section 2.15, *Roadside Restoration*, but shall not adversely affect the strength limit state, extreme event limit state, service limit state, and safety requirements for the traffic barriers and railings.

The Design-Builder shall not use precast concrete barriers for permanent applications on bridges or bridge approach slabs. Permanent barriers shall be reinforced concrete cast-in-place in the final position.

The Design-Builder shall cast a minimum of two 2-inch diameter conduit pipes with junction box pairs (one for each conduit pipe) spaced at 180 feet maximum

into all new concrete bridge barriers for the full length of the barrier, including barriers on bridge approach slabs and barriers on walls that abut approach slabs or bridges. Each conduit pipe shall terminate at separate Type 1 junction boxes within 15 feet of the exit from a barrier. The Design-Builder shall furnish and install conduit expansion, deflection devices, or both at all expansion joints, points where the conduit exits from the barrier, and any other location where movement is expected.

2.13.4.1.12 Bridge-Mounted Utilities

Existing Utilities shall be removed from the existing bridge and relocated in coordination with the type of replacement structures. Utility installation requirements on new and existing structures shall be in accordance with Attachment 5d to Appendix 5, and Section 15.10 of the WSDOT *Bridge Design Manual*.

2.13.4.1.13 Temporary Structures

Temporary structures refer to any temporary bridge, detour bridge, portion of a bridge, or buried structure that will not remain upon the Culvert Bundle Physical Completion of each Culvert Bundle. Temporary structures shall accommodate vehicular and pedestrian traffic and meet the following criteria:

The Design-Builder shall design temporary structures in accordance with the WSDOT *Bridge Design Manual*, WSDOT *Geotechnical Design Manual*, *AASHTO LRFD Bridge Design Specifications*, and *AASHTO Guide Specifications for LRFD Seismic Bridge Design*. Welding on any steel elements shall be in accordance with AWS D1.5. Components of temporary structures which will be incorporated into the permanent structures shall meet the requirements for the permanent structures. All temporary structures shall be designed for live load deflection less than or equal to L/800 as defined by *AASHTO LRFD Bridge Design Specifications*. Temporary structures with vehicular traffic shall be designed for a minimum of 75 percent of the HL-93 live load as defined in the *AASHTO LRFD Bridge Design Specifications*, except when there is no practical detour route available for freight, then 100 percent of the HL-93 live load shall be used.

The minimum width of the driving surface for the temporary detour bridge structure shall be 17 feet. The driving surface of the temporary detour structure shall be durable and skid resistant lasting through the Project duration. Temporary traffic barriers shall be in accordance with Section 1610 of the WSDOT *Design Manual* and the WSDOT *Bridge Design Manual*.

The Design-Builder may use new and salvaged structure members for the temporary structure, but it shall be the responsibility of the EOR to ensure all members meet all appropriate material properties for their intended function, such

as dimensions, yield strength, tensile strength, ductility, toughness, chemical composition, weldability, and corrosion resistance. Material testing of the structure members may be required in order to provide assurance that the appropriate requirements of material properties have been met. For salvaged steel materials where the grade of steel cannot be positively identified, the design stresses for the steel shall conform to Section 6-02.3(17)B3 of the Standard Specifications. Salvaged structure members include previously used members from other bridges or structures, members that have been fabricated but never installed in a structure, and members from a prefabricated structural system designed specifically for repeated temporary use. Concrete girder design sheets shall be provided indicating concrete strength, strand type and pattern, shear reinforcement, and other pertinent information. The Design-Builder shall provide supporting documentation for all selected temporary members to WSDOT for Review and Comment.

All foundations of the temporary structures shall be located outside the horizontal limits of the Ordinary High Water for ***to be determined during the Phase 1 Service Period*** and the bottom of foundations shall be located a minimum of 2 feet below scour estimated for the 2-year MRI water flows. Before the Culvert Bundle Substantial Completion of a Culvert Bundle, the foundations for temporary structures shall be completely removed. **[Note: This paragraph will be updated as part of the Project Implementation Amendment.]**

Design Documents and specifications for all temporary detour structures shall be reviewed and approved by the SLE. Prior to opening to traffic, all temporary detour structures shall be reviewed in the field for compliance with the Design Documents and specifications by the SLE, who shall advise WSDOT of any deviations. The Design-Builder shall be responsible for the maintenance of all temporary structures.

2.13.4.2 At-Grade Traffic Barriers

At-grade traffic barriers shall be designed in accordance with the WSDOT *Bridge Design Manual* and shall use the design criteria for TL-4. Existing barriers that require modification shall be replaced by removing the existing barrier to the next joint.

2.13.4.3 Retaining Wall Design Criteria

The Design-Builder shall design and construct permanent retaining walls for the Project. Retaining walls shall be of the following types:

- Proprietary structural earth walls in accordance with Section 6-13 of the Standard Specifications.

- Standard permanent geosynthetic retaining walls in accordance with Sections D-3.09, D-3.10, and D-3.11 of the Standard Plans and Section 6-14 of the Standard Specifications.
- Standard reinforced concrete cantilevered retaining walls in accordance with Sections D-10.10 through D-10.45 of the Standard Plans and Section 6-11 of the Standard Specifications.
- Soil nail walls in accordance with Section 6-15 of the Standard Specifications.
- Soldier pile walls in accordance with Sections 6-16 and 6-17 of the Standard Specifications.
- Soldier pile tieback walls in accordance with Sections 6-16 and 6-17 of the Standard Specifications.

The Design-Builder shall design walls in accordance with TR Section 2.6 *Geotechnical*, the *WSDOT Geotechnical Design Manual*, the *WSDOT Bridge Design Manual*, and the *AASHTO LRFD Bridge Design Specifications*. The Design-Builder may use the Standard Plans retaining wall as a basis for special design retaining walls to meet the Project seismic design criteria or to meet the aesthetic requirements for the Project, in accordance with TR Section 2.15, *Roadside Restoration*. Aesthetic modifications shall not adversely affect the strength and safety requirements of the retaining walls. Special design retaining walls shall be stamped and signed by the Design-Builder.

Fall protection shall be provided at the top of all retaining walls and retaining wall terraces in accordance with Section 730.04(7)(b) of the WSDOT *Design Manual*. Fall protection shall be of the standard guardrail type, as described and in accordance with the requirements in the WAC 296-155-24615(2) and WAC 296-155-24609. Timber shall not be used as a material type for standard guardrails. The Standard Plans Chain Link Fence Types 3 and 4, and Glare Screen Types 1 and 2 are not acceptable fall protection systems. For fall protection features that are exposed to the public, the design of railings shall be in accordance with Chapter 13 of the *AASHTO LRFD Bridge Design Specifications.*

The Design-Builder shall evaluate potential impacts to Utilities crossing under proposed walls and incorporate mitigation measures to avoid conflicts and detrimental effects including, but not limited to, settlement and surcharge loading.

Rock walls, gravity block walls, and gabion cribbing shall not be used for retaining earth or as retaining walls.

2.13.4.3.1 Temporary Retaining Walls

Temporary retaining wall refers to any wall or portion of wall that retains earth adjacent to public vehicular traffic and will not remain functional upon Culvert Bundle Physical Completion of each Culvert Bundle.

The Design-Builder may reuse structural components of temporary retaining walls as part of permanent retaining wall systems, provided all of the structural support elements and materials of the temporary retaining walls meet the requirements of the permanent structure standards. Timber piles will be allowed as foundations for temporary retaining walls where allowed by the Project's permits. Maintenance of temporary retaining walls shall be the Design-Builder's responsibility.

The Design-Builder shall remove all portions of temporary retaining walls before the Culvert Bundle Substantial Completion of each Culvert Bundle. If field conditions prohibit the complete removal, the Design-Builder shall remove the walls to 2' below final grade, however, all portions of the wall within Ordinary High Water shall be removed in all cases.

2.13.4.4 Buried Structures Design Criteria

The Design-Builder shall use only cast-in-place or precast reinforced concrete, or metal structural plate for buried structures.

Buried structures and associated headwalls, wingwalls and connected barriers, rails, and fall protection shall be designed and constructed in accordance with the WSDOT *Geotechnical Design Manual*, WSDOT *Bridge Design Manual*, *AASHTO LRFD Bridge Design Specifications,* and the *AASHTO LRFD Bridge Construction Specifications*. The AASHTO operational classification load modifier for the buried structure shall be that for typical bridges unless noted otherwise.

Corrosion and abrasion shall be considered as specified in the WSDOT *Bridge Design Manual*.

The structural clear span of a buried structure shall be used to determine the buried structure class. When supporting a Roadway, the structural clear span shall be the widest horizontal opening from the interior face to the interior face of the end walls measured parallel to the roadway centerline. When not supporting a Roadway, the structural clear span shall be the widest horizontal opening from the interior face to the interior face of the end walls measured perpendicular to the buried structure centerline.

Structure Class	Structural Clear Span
Class 1	Less than 20.0 feet
Class 2	20.0 feet and greater

Class 2 buried structures and associated headwalls and wingwalls shall include seismic design and ground failure mitigation in accordance with the WSDOT *Bridge Design Manual* and WSDOT *Geotechnical Design Manual*. This includes,

at a minimum, design for seismic loads in accordance with the *AASHTO Technical Manual for Design and Construction of Road Tunnels – Civil Elements* Chapter 13, for the seismic effects of transient racking or ovaling deformations. The *AASHTO LRFD Bridge Design Specifications* exemption from seismic loading shall not apply.

All buried structures and associated headwalls and wingwalls shall be designed for scour from the design flood (100-year flood event) and the check flood (500-year flood event) in accordance with the *WSDOT Bridge Design Manual* and the *AASHTO LRFD Bridge Design Specifications* unless additional design criteria is documented in the Final Hydraulic Design report. Channel migration shall be considered.

Headwalls are structural elements that are end treatments connected to buried structures, including, at a minimum, parapets, slope collars, cutoff walls, and inverts. Headwalls shall be reinforced concrete.

Wingwalls are retaining wall structure elements adjacent to or above a buried structure end or headwall. Portions of wingwalls below the 100-year mean recurrence interval water surface shall be reinforced concrete or have a reinforced concrete fascia.

When supporting a Roadway, the fill depth shall be defined as the total backfill and surfacing depth above the top of the buried structure. When not supporting a Roadway, the fill depth shall be defined as the total backfill above the top of the buried structure.

Structural Earth Wall wingwalls shall not use metallic ground reinforcement below the 100-year mean recurrence interval water surface unless the pH in accordance with WSDOT T 417 of the water in front of the wall and of the groundwater is within the range of 5.0 and 10.0.

Fall protection shall be provided at the top of all buried structures and associated headwalls and wingwalls in accordance with the WSDOT *Design Manual*. Fall protection shall be of the standard guardrail type, as described and meeting the requirements in the WAC 296-155-24615(2) and WAC 296-155-24609. Timber shall not be used as a material type for standard guardrail. The Standard Plans Chain Link Fence Types 3 and 4, and Glare Screen Types 1 and 2 are not acceptable fall protection systems. For fall protection features that are adjacent to public pedestrian features such as sidewalks, the design shall be in accordance with Chapter 13 of the *AASHTO LRFD Bridge Design Specification* for pedestrian railing.

2.13.4.4.1 Concrete Structures

When the buried structure is located in a corrosive environment as defined in the WSDOT *Bridge Design Manual*, corrosion-resistant reinforcement defined in the

WSDOT *Bridge Design Manual* shall be used. The minimum coverage requirements for direct exposure to salt water and coastal situations of the *AASHTO LRFD Bridge Design Specifications* shall apply.

When the Fill Depth of the buried structure is less than 2 feet at any point above the Structure, all reinforcement in the top slab shall be corrosion resistant as defined in the WSDOT *Bridge Design Manual LRFD M 23-50*. Reinforcement in the top slab need not be corrosion-resistant when a concrete deck meeting the requirements for a "Type 4 Bridge Deck Protection System" as defined in the WSDOT *Bridge Design Manual* is provided.

When the top of the buried structure is directly exposed to vehicular traffic, a concrete or HMA overlay, or reinforced concrete deck shall be provided. For an HMA overlay, the minimum concrete cover from the top surface of the buried structure to the top mat of reinforcement shall be 2½ inches. For a concrete overlay or reinforced concrete deck, the minimum concrete cover from the top surface of the buried structure to the top mat of reinforcement shall be 2 inches. When the top of the buried structure is directly exposed to vehicular traffic, bridge approach slabs shall be provided. Approach slabs may be deleted if the requirements in section 2.13.4.1.7 are met.

All reinforcement in precast units shall be of the same type. However, if epoxy-coated reinforcing is required in the lid of a buried structure, epoxy-coated reinforcing is not required in the walls or base slabs, unless the structure is located in a corrosive environment.

2.13.4.4.2 Metal Structural Plate Structures

Steel structural plates shall not be used in locations conforming to corrosive environments as defined in the WSDOT *Bridge Design Manual*.

Where the buried structure supports a Roadway and the minimum Fill Depth is less than 8 feet, the Design-Builder shall provide protection against Roadway de-icing salts and chlorides by one of the following methods:

1. Providing an impermeable geomembrane with welded seams in the backfill over the Structure that is sloped to drain water away from the Structure. The membrane shall be a minimum 30 mil thick polyvinyl chloride, ethylene interpolymer alloy, or polyurethane polymer, or a combination of these polymers.
2. Preventing roadway drainage from entering into the fill above the buried structure.
3. Providing additional metal plate thickness.

2.13.4.4.3 Load Rating Report

For a Class 2 buried structure supporting a Roadway, the Design-Builder shall submit a load rating report in accordance with the WSDOT *Bridge Design Manual*, except in the following cases:

- For a simple span (single barrel) buried structure when the Structural Clear Span is less than or equal to 24 feet and the minimum Fill Depth is greater than 13 feet.
- For a simple span (single barrel) buried structure when the Structural Clear Span is greater than 24 feet and the minimum Fill Depth exceeds the Structural Clear Span.
- For a multiple span (multiple barrel) buried structure when the Fill Depth exceeds the Structural Clear Span.

2.13.4.4.4 Stormwater Vault

This Section is intentionally omitted.

2.13.4.5 Noise Wall Design Criteria

This Section is intentionally omitted.

2.13.4.6 Sign Structures, Closed-Circuit Television Camera Structures, Toll *Gantries, and Overhead Lighting Structures*

This Section is intentionally omitted.

2.13.4.6.1 Variable Message Signs

This Section is intentionally omitted.

2.13.4.6.2 Toll Rate Signs

This Section is intentionally omitted.

2.13.4.6.3 Closed-Circuit Television

This Section is intentionally omitted.

2.13.4.6.4 Toll Gantries

This Section is intentionally omitted.

2.13.5 *Construction Criteria*

Construction equipment exceeding the legal load shall not be operated on structures without WSDOT's written approval. Refer to Section 1-07 of the *General Provisions* for additional requirements.

2.13.5.1 *Structure Monitoring Program*

All new and existing bridges, retaining walls, and other structures that have the potential to be damaged by the work shall be considered Sensitive Structures. The Design Builder shall identify all new and existing structures that are considered Sensitive Structures based on the proposed Work and develop a monitoring program. Sensitive Structures shall include at a minimum the following structure:

*** To be Determined during Phase 1 Design Services ***.

The monitoring program shall be used to assess the stability and safety of the structure for public use by comparing baseline measurements to routine monitoring measurements after the commencement of construction activities within the Project limits. The monitoring program shall include the following elements for a pre-construction condition survey and routine monitoring of the structure:

Pre-construction Condition Survey: There shall be two baseline Structure surveys. The first survey shall be performed at least 14 Calendar Days prior to the commencement of any construction activities (soil/rock removal, pile driving, structural Work, etc.) for the *** To be Determined during Phase 1 Design Services ***. The second survey shall be performed 24 hours prior to starting the construction activities in order to verify the stability of the baseline measurements. Both surveys shall document visible cracks, defects, and any unusual conditions. Baseline measurements shall include estimated effects due to temperature, traffic impacts, etc. on the displacement measurements. The first survey shall include the installation of survey targets on the structure to track permanent displacements. See Appendix S for recent WSDOT condition inspection documents for existing structures.

- Bridge Surveys shall be performed on all spans and piers of the bridge and shall provide a geometric baseline for the bridge deck and the location and elevation of bridge piers. At a minimum, survey targets shall be located on each exterior column of interior piers, within 2 feet vertical distance below the top of each column, and within 2 feet vertical distance above the existing ground line or top of the exposed footing.
- Retaining Wall Surveys shall be performed at the wall ends and intervals no greater than 50 ft along the wall length. Survey targets shall be located within 2 ft of the top of the wall.
- *** To be Determined during Phase 1 Design Services ***

Routine Monitoring: Monitoring of the survey targets on the structure shall start within 24 hours after the commencement of any construction activities, then continue at least each Calendar Day until the structure is no longer in service to the public, vehicular and pedestrian traffic is shifted to the temporary detour alignment, and construction activities adjacent to the structure that impact the

stability are completed. Monitoring shall include surveying the target locations (x, y, and z values) a minimum of once per Calendar Day and uploading the survey data the same day to an online database. Access to the online database shall be provided to WSDOT up to Substantial Completion of the Project.

- The trigger, maximum, and repair displacement values shown below define the threshold levels to implement additional monitoring requirements and adjust construction practices as required. The Design-Builder may adjust the threshold levels depending on the results of the Pre-construction Condition Survey. The Design-Builder shall notify the WSDOT Engineer of the selected threshold levels 24 hours prior to starting construction activities. Threshold levels are compared to the resultant combination of vertical and horizontal displacements of the survey targets. Displacement measurements shall be taken to a precision of 0.01 feet.

Threshold Levels for Permanent Displacements (feet)				
Structure	Element	Trigger Level	Maximum Level	Repair Level
$$ To be Determined during Phase 1 Design Services $$	***$$ To be Determined during Phase 1 Design Services $$***	***$$ To be Determined during Phase 1 Design Services $$***	***$$ To be Determined during Phase 1 Design Services $$***	***$$ To be Determined during Phase 1 Design Services $$***

Damaged, missing, or non-functioning survey equipment or targets shall be replaced and re-baselined within 24 hours. The Design-Builder shall develop a Corrective Action Plan describing specific actions to be taken if permanent displacements exceed the threshold levels given above. This plan shall be submitted to the WSDOT Engineer for Review and Comment at least 14 Calendar Days prior to any construction activities.

Structural damage to the structure caused by the Design-Builder's construction activities and creating safety concerns for public use on the structure shall be repaired regardless of the measured displacement levels. The Design-Builder shall be responsible for all associated design and repair costs, and implementation of repairs to restore stability and safety to the structure for public use.

The monitoring program shall include the following elements:

- ***To be Determined during Phase 1 Design Services***

The Design-Builder shall perform remedial measures for each threshold level as described below:

- Trigger Level: Notify the WSDOT Engineer on the same Calendar Day that the trigger level has been exceeded. Report displacement measurements to the WSDOT Engineer until it is verified that movement has stopped.

Increase frequency of future monitoring for each affected survey target to two readings daily with a minimum of 6 hours between readings and monitor the adjacent targets at the same frequency until movements have stabilized. Implement procedures to limit additional movement and protect the affected facility.

- Maximum Level: Verify measurements and notify WSDOT immediately if the maximum level has been exceeded. Increase frequency of future monitoring for all survey targets to three readings daily with a minimum of 4 hours between readings. Report displacement measurements to the WSDOT Engineer until it is verified that movement has stopped. WSDOT may suspend associated ground-disturbing activities and require the Design-Builder to submit alternative proposals for minimizing further movement. If Work is suspended, the Design-Builder shall obtain approval prior to restarting ground-disturbing activities.
- Repair Level: All construction activities affecting the structure shall be suspended immediately and WSDOT shall be notified immediately to assess the stability risk and safety of the structure for public use. The Design-Builder, SLE, and WSDOT Engineer shall determine the extent of temporary repairs required for the structure before construction activities are allowed to resume. Structural repairs shall be designed and constructed by the Design-Builder and SLE to restore stability and safety of the structure for public use.

2.13.6 *Bridge Maintenance Requirements*

2.13.6.1 Existing Bridge Expansion Joint Rehabilitation

This Section is intentionally omitted.

2.13.6.2 Bridge Inspection and Maintenance Access

The Design-Builder shall design, detail, and construct all bridge superstructures, joints, and bearings to be accessible for WSDOT inspection and maintenance.

The Design-Builder shall design, detail, and construct all joints and bearings to be replaceable. All bearing locations shall be designed with jacking points and adequate clearances to facilitate future bearing replacement. Jacking points shall be designed to support 200 percent of the calculated lifting load.

All exterior surfaces of superstructures, including bearings and between girders, shall be accessible by an Aspen Aerial A-62 Under Bridge Inspection Truck, a 40-foot bucket truck, or a 15-foot ladder. “Accessible” is defined as within arm’s reach of an inspector. Technical details including the flight path for an Aspen Aerial A-62 can be located on the Aspen Aerials website.

Pipe railing shall be provided along the girder webs for future maintenance and inspection access and shall be located and detailed in accordance with sheet 6.4-A9 of the WSDOT *Bridge Design Manual*.

For box girders with permanent access, access doors shall be provided at both ends of the bridge. When access is provided through webs, this access shall be provided at both ends of the bridge.

For steel box girders with permanent access, the Design-Builder shall paint the interior of steel box girders the color white (SAE AMS Standard 595, Color No. 17925) and shall provide fluorescent inspection lighting and electrical power. Lighting fixtures, light switches, and duplex receptacles shall be located inside the steel box girders in a manner consistent with the WSDOT *Design Manual*.

The Design-Builder shall notify WSDOT 30 Calendar Days prior to any new bridge or buried structure being open to traffic so that WSDOT can schedule an inventory inspection by the WSDOT Bridge Preservation Office.

2.13.7 *Submittals*

2.13.7.1 Structure Design Submittals

Project submittals shall include, at a minimum, the required submittals in this Section.

2.13.7.1.1 Preliminary Design Submittal

The Design-Builder shall submit to WSDOT for Review and Comment on preliminary design Drawings on WSDOT standard sheets in accordance with the WSDOT *Bridge Design Manual* Preliminary Plan Checklist for all bridges, buried structures, and other structures. The stamp of the EOR and SLE shall be applied in accordance with WAC 196-23-020.

2.13.7.1.2 Final Design Submittal

The Design-Builder shall submit to WSDOT for Review and Comment on final design Drawings on WSDOT standard sheets in accordance with the WSDOT *Bridge Design Manual*. The Design-Builder shall submit final technical Specifications, design calculations, and supporting reports for all bridges, buried structures, and other structures. The stamp of the EOR and SLE shall be applied in accordance with WAC 196-23-020.

2.13.7.1.3 Released for Construction Document Submittal

The Design-Builder shall submit Released for Construction (RFC) Documents to WSDOT for all structural Work related to bridge and structures construction, including drawings, technical Specifications, design calculations, and supporting reports, along with verification that all written review comments for the

preliminary and final Design Documents submittals have been resolved. The RFC Documents shall include the stamp and signature of the EOR and SLE in accordance with WAC 196-23-020.

2.13.7.1.4 Design Calculations

The Design-Builder shall submit to WSDOT for Review and Comment on complete sets of legible calculations to support all structural engineering designs described in this Section. Complete sets of calculations shall be included with each Design Documents review submittal.

All RFC calculations shall include the stamp and signature of the EOR and SLE in accordance with WAC 196-23-020. The calculation sets shall include the following:

- Cover Sheet - The name of the Project, structure name, designer/checker name, date (month, day, and year), and supervisor's name shall be listed. The stamp and signature of the EOR and SLE shall also be included.
- Index Sheets - These shall include an index by subject with the corresponding design calculation sheet numbers.
- Design Calculations - Design calculation sheets shall be numbered. The calculations shall include design criteria; loadings; structural analysis; results; member capacities; geotechnical calculations; horizontal and vertical settlement calculations; deflection diagrams; long-term creep diagrams for horizontal flexural members; and all computer input and output data (reduced to an 8.5 by 11-inch sheet size). In addition, electronic files of spreadsheets and computer input/output files used to support the design calculations shall be submitted.

2.13.7.2 Working Drawings

All Working Drawings shall be submitted as Type 2 Working Drawings unless otherwise noted. If a Working Drawing is submitted to the EOR for approval as part of the Design-Builder's QMP, it shall be submitted to WSDOT as a Type 3 or 3E Working Drawing after approval from the EOR.

2.13.7.2.1 Shop Drawings

The Design-Builder shall submit to WSDOT shop drawings for all steel elements, precast concrete elements, post-tensioning reinforcement, bearings, expansion joints, railings, barriers, luminaires, drainage structures, reinforcing steel, and piles/drilled shafts prior to implementing Work based on the shop drawings. The EOR shall review all shop drawings prior to submittal to WSDOT. The Design-Builder shall submit the final approved shop drawings prior to Culvert Bundle Completion of each Culvert Bundle as part of the As Built Plans in accordance

with TR Section 2.13.7.5.1, *Plans*. The shop drawings shall include, at a minimum, the following information:

- Size of member and fasteners
- Length dimensions
- Finish, such as galvanizing, anodizing, and painting
- Weld size and type and welding procedures
- Strand or steel reinforcing bar placement
- Post-tensioning reinforcement tensioning procedure, stress calculations, and elongations
- Post-tensioning anchorage details
- Fabrication-reaming, drilling, and assembly procedures
- Wall penetrations
- Erection procedures for steel elements
- Handling and erection procedures for precast concrete elements, including complete details of all temporary supports, bracing, and inserts placed for lifting, assembly, and erection
- Material specifications
- For buried structures, an installation plan. The installation plan shall include the manufacturer's installation instructions and the installation and backfill procedure. The installation plan shall cover all aspects of installation, including but not limited to bedding and foundation construction, placement, assembly, backfilling requirements, and anticipated deflections during backfilling. The installation plan shall address how the structure is braced and monitored during and after construction and backfilling to ensure the finished product meets all design and construction requirements and all geometric tolerances. Minimum backfill cover over the structure to support construction equipment loadings shall be specified

2.13.7.2.2 Falsework, Forms, and other Temporary Structures

The Design-Builder shall submit to the WSDOT Engineer for Review and Comment Type 3 or Type 3E Working Drawings with supporting design calculations for falsework, forms, construction work bridges, temporary retaining walls, temporary bridges, and other temporary structures.

The Design-Builder shall submit to WSDOT for Review and Comment procedures and Working Drawings with supporting design calculations for critical construction processes. Critical construction processes include, at a minimum, bridge removal, bridge approach demolition, and jacking pits.

All final Design Documents and calculations for the falsework, forms, construction work bridges, temporary retaining walls, temporary bridges, other

temporary structures, demolition, erection, and installation shall bear the stamp and signature of a Licensed Professional Engineer or Licensed Professional Structural Engineer.

2.13.7.2.3 Shaft Installation Plans

Plans for shaft installation, and for slurry and slurry-contacted spoils disposal (as referenced in Division 6 of the Standard Specifications), shall be submitted to the WSDOT Engineer for Review and Comment.

2.13.7.3 Plan Revisions During Construction

The Design-Builder shall incorporate calculations for revisions made during construction into the design/check calculation file when construction is completed. Whenever new plan sheets are required as part of a Design and Construction Requirements Change, the information in the title blocks of these sheets shall be identical to the title blocks of the PDB Contract they are for. Every revision shall be assigned a number. The assigned number shall be located both at the location of the change on the sheet and in the revision block of the plan sheet along with an explanation of the change.

2.13.7.4 Load Rating Report

The Design-Builder shall complete and submit a load rating report as described in Section 15.12 of the WSDOT *Bridge Design Manual* to WSDOT for Review and Comment at least 90 Calendar Days before a structure is opened to vehicular traffic.

The Design-Builder shall provide the load rating in BRIDG software format, using system input. If BRIDG is not suitable for a specific structure type rating, then PGSuper, CSI Bridge, or structural software as approved by WSDOT may be used to analyze the forces in vehicular structures or elements of a vehicular structure. The forces and capacities shall be tabulated in a Microsoft Excel spreadsheet for future updates to the ratings or to check permit loads.

The Design-Builder shall submit all electronic files generated for the load rating analysis electronically.

2.13.7.5 End of Project Submittals

All Design Documents overseen by the SLE shall be submitted prior to Culvert Bundle Completion and shall bear the stamp and signature of the SLE except as otherwise required in this Section.

2.13.7.5.1 As Built Plans

The Design-Builder shall prepare As Built Plans for bridges, buried structures, and other structures on WSDOT standard sheets in accordance with the WSDOT

Bridge Design Manual. Plans shall be submitted on 11 by 17-inch white bond paper and as electronic CADD files in accordance with TR Section 2.1, *General Information,* and this Section. Final approved shop drawings for structures shall be included in the As Built Plans.

2.13.7.5.2 Calculations

The Design-Builder shall revise all calculations as necessary for the design covered by the scope of work to accommodate field changes. The calculations shall include all the items listed under "Design Calculations" previously specified in this Section.

2.13.7.6 Cost Reporting for Permanent Noise Barrier

This Section is intentionally omitted.

2.13.7.7 Miscellaneous Submittals

This Section is intentionally omitted.

End of Section